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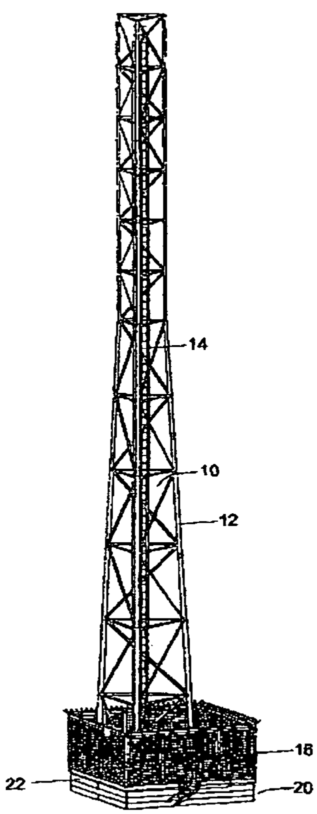
(54) Title: FOUNDATION FOR A TOWER AND A METHOD FOR ITS DEPLOYMENT ON SITE



(57) Abstract: A foundation (20) for a tower (10) is formed of a plurality of prefabricated slabs (24-30,28',29) coupled together so as to function as a monolithic foundation (20).

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FOUNDATION FOR A TOWER AND A METHOD FOR ITS DEPLOYMENT ON SITE

FIELD OF THE INVENTION

The present invention relates to foundations for towers in general and, in particular, to a foundation for telecom towers and similar applications.

BACKGROUND OF THE INVENTION

In the implementation of a telecom network, a power transmission network or a similar network, first, sites are selected and planned, then building permits for the sites, including the tower sites, are obtained, and afterwards, the sites are built. In the conventional case, a concrete foundation is cast at the tower site. A normally prefabricated steel tower is assembled, erected and affixed to the foundation, in any of a number of known fashions, generally including screwing or bolting the tower base to the foundation. This provides a permanent tower facility, but takes a relatively long time to deploy, due to the fact that the foundation concrete must cure sufficiently to withstand the tower base loads before the tower can be erected and affixed to it.

Increasingly, new Telecom Networks (primarily mobile telephone networks) tend to be built under fast roll-out constraints. On the other hand, it is increasingly hard to obtain building permits for the sites (primarily the tower sites) of such networks.

Accordingly, there is a long felt need for, and it would be very desirable to have, a rapidly deployable telecom or similar tower, which would utilize a prefabricated foundation solution.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a foundation for a tower, the foundation comprising a plurality of prefabricated slabs coupled together so as to function as a monolithic foundation.

According to one embodiment of the present invention the shape of the surface area of the foundation can be substantially square, rectangular, circular, octagonal or any other geometrical shape.

According to another embodiment of the present invention the foundation includes a plurality of layers, each layer including a plurality of adjacent slabs joined transversely to adjacent layers, wherein the thickness of each slab in a layer is substantially the same.

According to one embodiment of the invention the surface area of each slab is one half of the surface area of each said layer.

According to a preferred embodiment of the invention, each slab includes a plurality of horizontally spaced throughgoing substantially vertical bores for accepting long bolts or elongated connecting members having threaded at least end portions. Said bores further include lining sleeves.

According to yet another preferred embodiment of the invention, at least each slab at the bottom layer of said foundation, further comprises substantially vertical recesses at one end of said throughgoing vertical bores, wherein said recesses have a cross-section which is larger than the cross-section of said bores.

Further according to a preferred embodiment of the invention, the recesses have a specially shaped non-circular cross-section for housing said long bolts or connecting members, securing nuts, locking nuts, plate washers and non-rotating nut holding devices for preventing rotation of said connecting members when tightening said securing nuts.

According to a preferred embodiment, said recesses are arranged for snug fit housing of said heads of long bolts and securing nuts.

According to yet another preferred embodiment, said recesses further house non-rotating nut holding devices which have a non-circular cross section equal to or

larger than the cross section of said securing and locking nuts, and are adapted to snug fit into said recesses and snug hold said locking nut, for preventing rotation of said connecting members. Said non-rotating nut holding devices comprise a substantially flat surface having surface area dimensions and contour suitable for snug fitting into said recesses, a circular hole suitable for inserting said connecting member and co-axial thereto, and two parallel walls projecting from said flat surface substantially perpendicularly thereto, wherein each wall is positioned at an equal distance from the center of said circular hole and spaced apart at a distance substantially equal to the length between two opposite ribs of said locking nuts for snug fit housing and holding of said locking nut. According to another preferred embodiment, said bottom layer slab further comprises a metal plate including holes co-axial with said recesses and bores, for distributing loads created by tensioning of said long bolts or connecting members and providing a support surface against which said heads of long bolts or securing nuts abut when said connecting members are tightened.

According to yet another preferred embodiment, all of said long bolts or connecting members or at least some of them, protrude from the top layer of the foundation for joining together all said layers of the foundation and connecting said tower to said long bolts or connecting members. According to still another preferred embodiment, each said layer includes slabs substantially similar to said bottom layer slab. According to one embodiment, the top layer includes slabs substantially similar to said bottom layer slabs turned upside down.

There is also provided in accordance with the present invention a method of preparing a foundation for a tower, the method comprising:

preparing prefabricated slabs including throughgoing substantially vertical bores for receiving elongated connecting members;

preparing a site having a desired area;

placing a first layer of said prefabricated slabs on the site;

placing a second layer of said prefabricated slabs transversely on said first layer, while;

aligning said throughgoing receiving bores; and

joining together said first and second layers by means of said elongated connecting members passing through said aligned throughgoing receiving bores.

There is further provided in accordance with the present invention a method of preparing a foundation for a tower, further comprising placing additional layers of prefabricated slabs on said second layer and joining together all the layers by means of elongated connecting members passing through said aligned throughgoing bores in all the slabs.

The method according to another preferred embodiment of the present invention, further comprises placing prefabricated slabs having substantially vertical recesses at one end of said throughgoing vertical bores, at the bottom layer. According to a preferred embodiment, the method further comprises placing slabs substantially similar to said bottom layer slabs at any of the layers.

The method according to yet another preferred embodiment, further comprises placing slabs substantially similar to bottom layer slabs turned upside down at the top layer.

According to another preferred embodiment, said method further comprises the step of assembling onto bottom end portions of connecting members said securing nuts, said non-rotating nut holding devices and said locking nuts before inserting connecting members through said first layer, extending upwardly.

According to yet another preferred embodiment of the present invention, said method further comprises the step of inserting connecting members through said first layer, extending upwardly, before the step of placing the slabs of the first layer on the ground.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be further understood and appreciated from the following detailed description taken in conjunction with the drawings in which:

Fig. 1 is a perspective view of a tower mounted on a foundation constructed and operative in accordance with one embodiment of the present invention;

Fig. 2 is a schematic plan view of the tower of Fig. 1;

Fig. 3 is a plan view of a slab constructed and operative in accordance with one embodiment of the invention;

Fig. 4 is a partial sectional view of the slab of Fig. 3;

Fig. 5 is a partial sectional view of a bottom slab with recesses and bottom end portions of elongated connecting members, constructed and operative in accordance with an alternative embodiment of the invention;

Fig. 6 is a sectional view of a preferred metal liner for the bores and recesses shown in Fig. 5, constructed and operative in accordance with a preferred embodiment of the invention;

Fig. 7 is a partial sectional view of the foundation constructed and operative in accordance with an alternative embodiment of the invention;

Fig. 8 is a partial sectional view of the upper part of the foundation and partial sectional view of a leg of a tower and structural interface element, constructed and operative in accordance with an alternative embodiment of the invention;

Fig 9 is a plan view of two layers of the foundation constructed and operative in accordance with an alternative embodiment of the invention;

Fig 10 is a plan view of two layers of the foundation constructed and operative in accordance with an alternative embodiment of the invention;

Fig. 11 illustrates the non-rotating nut holding device, constructed and operative in accordance with an alternative embodiment of the invention; and

Fig. 12 is a partial sectional view of the upper part of the foundation, constructed and operative in accordance with an alternative embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a foundation for towers of telecom sites, power transmission lines, and the like, which facilitates rapid deployment due to the fact that the foundation is completely prefabricated. Except for a possible thin layer of lean concrete, which has no structural significance, no other on site casting is required in order to form a solid, stable foundation for the tower. Thus, one purpose of the invention

is to provide a solution for the tower sites of telecom and similar networks that require rapid deployment due to fast roll-out constraints.

The foundation according to the invention is formed of a plurality of prefabricated slabs. The heart of the invention is the method used to connect together the components of the foundation, and make them function effectively and safely as if they were one monolithic foundation. The foundation according to the invention can be permanent, or can be removable after temporary deployment, as preferred by the network builder. It is a particular feature of the invention that the foundation is very big and heavy in its entirety, so as to provide stability for the tower, yet its components can be prefabricated in dimensions and weights which are transportable by conventional means.

Referring now to Figs. 1 and 2, there are shown respective perspective and plan views of a tower foundation and tower constructed and operative in accordance with one embodiment of the present invention. As can be seen, a conventional prefabricated tower 10 is mounted on a foundation 20. Tower 10 can be any telecom tower or similar tower requiring a firm foundation to carry and stabilize it. Tower 10 can be of various conventionally required shapes (i.e. Lattice Tower or Monopole type), heights, or dimensions. The tower illustrated in Figs. 1 and 2 is a Lattice Tower with three legs 12, which are affixed to the foundation 20, as described below. A ladder 14 for climbing the tower, and a fence 16 or other security measures, may be optionally provided, as known.

The tower foundation according to the present invention is formed of several layers 22, preferably at least four layers, as illustrated in Figs. 1 and 2. Each of the layers consists of at least two concrete slabs 24 (rectangular if the foundation is substantially square). It will be appreciated that each layer of the foundation according to the present invention consists of a plurality of slabs that are either identical or not identical in surface area shape and dimensions, depending on engineering choices or constraints. Also, the slabs of each layer may differ in surface area shape and dimensions from one layer to another. However, the slabs in each layer must be of suitable surface area dimensions and shape to cover the overall area of that layer, and the thickness of each slab within a given layer must be substantially equal. Still, the

thickness of each layer may vary, also depending on engineering choices or constraints. It will be further appreciated that the surface area of the foundation according to the present invention can be of various geometrical shapes, such as substantially square, rectangular, circular, octagonal, etc.

Referring now to Fig. 9, there is shown a substantially square foundation wherein each layer consists of 3 rectangular slabs 25, 26 and 27, which can differ from one another in surface area dimensions. Slabs 25 and 27 have different dimensions than slab 26, and slabs 25 and 27 may be identical or not identical.

Referring now to Fig. 10, there is shown a substantially octagonal foundation wherein each layer consists of 3 slabs. Slabs 28 are identical but are of different surface area dimensions and shape from slab 29. During the process of assembling the foundation on site, the slabs are stacked in layers in a criss-cross fashion, so that their long dimensions are arranged in alternating transverse directions. Thus, in Fig. 2, the two slabs 24 of the top most layer are indicated by a solid line, while the slabs 24' of the layer beneath it are indicated by a broken line. In Fig. 9, slabs 25, 26 and 27 of the top most layer are indicated by a solid line, while the slabs 25', 26' and 27' of the layer beneath it are indicated by a broken line. In Fig. 10, slabs 28 and 29 of the top most layer are indicated by a solid line, while the slabs 28' and 29' of the layer beneath it are indicated by a broken line. When the slabs are all tightly fastened together, they form a monolithic "Raft" type foundation for the tower.

Referring now to Fig. 3, there is shown a plan view of a slab 30 constructed and operative in accordance with one embodiment of the invention. Slab 30 is an elongate slab having a pre-selected dimensions and thickness, which depend on the design constraints of the particular tower. A plurality of substantially vertical throughgoing bores 32 are provided through slab 30, as seen in Figs. 3 and 4. Bores 32 are arranged to allow long bolts or elongated connecting members which may be threaded or have threaded end portions, to pass through said bores 32 for coupling the slabs of all the layers together. Bores 32 are preferably lined with a metal or other liner or sleeve 34 during casting, so as to facilitate accurate placing of all designed bores 32 in the slab. Accurate placing of the bores is imperative for alignment of each respective bore 32 in

all the layers of the foundation, thus allowing insertion of said long bolt or elongated connecting member through respective bore 32 of all the layers. Typically slab 30 is for use in layers of the foundation other than the bottom layer.

Referring to Fig. 5, there is shown a sectional view of a bottom slab 40 including the bottom end portions of the long bolts or elongated connecting members 47 and 47', constructed and operative in accordance with an alternative embodiment of the invention. According to a preferred embodiment of the invention, slab 40 turned upside down can be used at the top layer as well as at the bottom layer. Although not necessarily economical, slab 40 can also be utilized as any internal layer. Slab 40 includes throughgoing bores 42 and 42' merging into specially shaped and substantially vertical cylindrical recesses of non-circular cross-section 44 and 44' at one end of bores 42 and 42', respectively. According to a preferred embodiment, recesses 44 and 44' are shaped and sized for snug fit housing and holding of the bottom heads of the long bolts or of securing nuts 45 and 45' screwed on to the end portions of elongated threaded connecting members 47 and 47', which are inserted into bottom slab 40 and extend upwardly for connecting the layers of the foundation. Alternatively, the recesses may be shaped and sized for snug fit housing and holding of non-rotating nut holding devices 50 and 50', which have a non-circular cross section equal to or larger than the cross section of the securing nuts 45 and 45' and locking nuts 52 and 52', and are adapted to snug hold the locking nuts. Referring to Fig. 11, there is shown a non-rotating nut holding device 120, comprising a substantially flat surface 122 having surface area dimensions and contour suitable for snug fitting into the recesses 44 and 44' in slab 40, and a circular hole 124 having a diameter which is equal to or larger than the diameter of connecting member 47 and 47' and is co-axial with the connecting members, recesses 44 and 44' and bores 42 and 42'. Non-rotating nut holding device 120 further comprises two parallel walls 126 and 126' projecting from flat surface 122 substantially perpendicularly thereto, and each wall is positioned at an equal distance from the center of circular hole 124 and spaced apart at a distance substantially equal to the length between two opposite ribs of the locking nuts for snug fit housing and holding of said locking nuts, thus preventing the nuts from rotating.

Also, the recesses prevent the ends of said bolts or connecting members 47 and 47' from protruding downwards from the lower surface of the bottom layer. This feature of said recesses is imperative for even contact between the underside of the foundation and the soil sub-base prepared for erection of the foundation and thus for even load distribution of the weight of the foundation and tower on said sub-base.

Preferably, only the recesses in the slabs of the bottom layer need have a non-circular cross section of compatible shape and size of the bolt head or securing nut in the absence of access to these bottom heads or nuts. According to a preferred embodiment, the recesses can be of non-circular substantially cylindrical shape and size, through which the securing nuts can be indirectly held. As shown in Fig. 5, recesses 44 and 44' can have a substantially cylindrical non-circular cross section larger in size than the securing nuts 45 and 45'. According to this embodiment, elongated connecting members which may be threaded or have threaded end portions are used to join the layers of the foundation. When threaded connecting members 47 and 47' are used, before they are inserted into bottom slab 40, securing nuts 45 and 45' are screwed on to the bottom end portions of the connecting members, with or without plate washers 54 and 54'. Thereafter, non-rotating nut holding devices 50 and 50', are slipped, respectively, onto bottom end portions of connecting members 47 and 47' followed by locking nuts 52 and 52' which are screwed on to the bottom end portions of the connecting members, abut against non-rotating nut holding devices 50 and 50' and slide them up along the connecting members until they abut against securing nuts 45 an 45'. Once non-rotating nut holding devices 50 and 50' are locked between locking nuts 52 and 52' and securing nuts 45 and 45', the top portions of connecting members 47 and 47 ' are inserted respectively into recesses 44 and 44' and bores 42 and 42' of bottom slab 40, and securing nuts 45 and 45', non-rotating nut holding devices 50 and 50' and locking nuts 52 and 52' are placed in recesses 44 and 44', respectively. Thus, when securing nuts 74 and 74' are screwed on the end portions of the connecting members (shown in Fig. 7) for joining together all the layers of the foundation, non-rotating nut holding devices 50 and 50' abut against recesses 44 and 44' respectively and prevent the rotation of connecting members 47 and 47'. It will be appreciated, that locking non-rotating nut

holding devices 50 and 50' between locking nuts 52 and 52' and securing nuts 45 and 45', respectively, can also be accomplished by tightening securing nuts 74 and 74' which may rotate connecting members 47 and 47', respectively, until locking nuts 52 and 52' cause non-rotating nut holding devices 50 and 50' to abut against securing nuts 45 an 45', thus preventing further rotation of the connecting members.

According to an alternative embodiment, wherein recesses 44 and 44' snug fit bottom heads of the long bolts or of securing nuts 45 and 45', the locking nuts or non-rotating nut holding devices or both, may not be required. According to this embodiment, long bolts or connecting members 47 and 47', which have threaded end portions only, can be used to join the layers of the foundation. Thus, when these connecting members are used, securing nuts 45 and 45', with or without plate washers 54 and 54', are screwed on to the bottom end portions of the connecting members before their top end portions are inserted into bottom slab 40. When securing nuts 74 and 74' are tightened, connecting members 47 and 47', respectively, may rotate until securing nuts 45 and 45' reach the end of the threaded bottom end portion of the connecting members, thus preventing them from further rotation. When long bolts are used, no securing nuts are required at their bottom portions and their top end threaded portions are inserted into the recesses in bottom slab 40 and extend upwardly while their heads are snug fitted in recesses 44 and 44' which prevent the rotation of the long bolts when securing nuts 74 and 74' are tightened.

Non-rotating nut holding devices 50 and 50' are shaped so that, when inserted into recesses 44 and 44', any rotation of non-rotating nut holding devices 50 and 50' is prevented. It will be appreciated by those skilled in the art that the alternative arrangements described above are preferred for the bottom most layer of the foundation, on top of which all the other layers are placed, and to which there is no access once the slabs are in place.

The depth of recesses 44 and 44' from the bottom end of slab 40 is substantially smaller than the thickness of said slab but sufficiently deep to prevent the long bolts or connecting members from protruding downwards from the bottom layer.

The bores and recesses are formed during the casting of slab 40, preferably through use of a metal "cast-in" type liner, one embodiment of which is more clearly illustrated in Fig. 6. Said liner may be provided in individual segments, each forming a single bore and a single recess in the casted slab. Preferably, the lining of said bores and recesses is formed by grouping together a large number of bores and recesses. Such grouping together of two horizontally spaced apart bores and recesses is illustrated in Figs. 5 and 6. Grouping of more than two bores and recesses can be accomplished in the same manner.

Referring now to Fig. 6, there is shown a base plate 48 including holes 49 and 49' of a diameter equal to the diameter of bores 42 and 42', respectively, and located directly thereunder. Bore liners or sleeves 46 and 46', for forming bores 42 and 42' respectively, are attached on one side of plate 48 and larger substantially cylindrical recess liners or sleeves 43 and 43' for forming recesses 44 and 44', respectively, are attached on the other side of plate 48. Liners or sleeves 43 and 43', 46 and 46' and holes 49 and 49' are arranged, respectively, substantially co-axially; the two axes being spaced apart at a pre-selected distance. Metal plate 48 serves also as a base against which the securing nuts or heads of the long bolts abut directly or through washers or plate washers 54 and 54', as known in the art and as shown in Fig. 5. Thus, plate 48 serves to distribute the concentrated loads created by the tensioning of the long bolts or elongated connecting members.

A plurality of selected long bolts or elongated connecting members must protrude upward from the top surface of the top layer for connecting the tower to the foundation, whereas the remaining long bolts or connecting members, preferably, do not protrude from said top surface.

Now referring to Fig. 7, there is shown one preferred embodiment of the invention, wherein a bottom slab turned upside down is used to form the top layer. In this embodiment, recesses 72 and 72' are sized to allow the use of a fastening tool, such as a deep ring-wrench or the like, for tightening the securing nuts 74 and 74' on top of said non-protruding long bolts or connecting members 76 and 76'. The recesses 72 and 72' in the top layer, which house, respectively, said non-protruding long bolts or

connecting members 76 and 76', may be filled in with any type of grout material, if desired, to provide a smooth upper surface finish for the foundation. Fig. 7 further shows a partial cross section of internal layers 78, bottom layer 80 and full length of non-protruding long bolts or connecting members 76 and 76'.

In another preferred embodiment shown in Fig. 12, a bottom slab 140 is turned upside down and used as a top layer of the foundation. According to this embodiment, the size of recesses 142 and 142' does not allow the insertion and use of a fastening tool for tightening securing nuts 144 and 144' inside the recesses. Thus, there is provided a plate 146 comprising a plurality of holes having a diameter which is equal to or greater than the diameter of connecting members 148 and 148' and arranged substantially co-axially with the long bolts or connecting members which are inserted through said holes in plate 146. Securing nuts 144 and 144' are screwed on to the top end portion of connecting members 148 and 148' and abut against plate 146 directly or indirectly through plate washers 150 and 150', when tightened.

Now referring to Fig. 8, as aforesaid, some of the throughgoing long bolts or elongated connecting members 90 and 90' are utilized to affix the base plate 95 of the leg of the tower, either directly or indirectly to the long bolts or connecting members. As known in the art, due to design, manufacturing or construction imperfections, it is generally impossible or very difficult, to affix base plate 95 directly to the long bolts or connecting members. Thus, in the embodiment seen in Fig. 8 (as well as in Fig. 2), leg 94 of the tower is engaged to a structural interface element 96 by conventional bolts 100. In turn, said interface element 96 is affixed to the long bolts or connecting members 90 and 90', which also serve to couple the layers of the foundation underneath. Thus it may be further appreciated that the long bolts or connecting members can vary in length, whereas long bolts or connecting members 90 and 90' will be longer while used to affix the base of the tower to the foundation then the others which have no such role. There are further shown in Fig. 8 the top ends of the long bolts or connecting members protruding from slab 102, which is a bottom layer slab turned upside down. Also seen in Fig. 8 are ends of long bolts or connecting members 90 and 90' secured by securing nuts 98 which abut optionally against plate 92 and secure the joining of the foundation layers

by securing plate 92. Conventional bolts 100 are used for affixing interface element 96 to leg 94. It will be appreciated by those skilled in the art, that the coupling of the tower to the foundation is shown in Fig. 8 by way of an example only.

The dimensions of the slabs can vary somewhat, according to the type and size of the tower to be supported, the size of the site, and the design standards and norms required to be followed in the specific country in which the site is to be erected. Preferably, the foundation is symmetrical in the horizontal plane, e.g., square or circular, to permit ease of fabrication and layering in the transverse orientation, and since the direction of the force acting on the tower (e.g., wind or earthquake) cannot be normally predicted. The foundation can, alternatively, be asymmetrical. Most preferably, the foundation is substantially square and the slabs are standardized for groups of towers having similar construction requirements. The horizontal dimensions of the slabs should normally be limited by the constraints of conventional transportability (i.e. width and length not exceeding those of conventional truck pallets). Preferably, the foundation according to the present invention comprises at least 4 layers, whereas the thickness of the slabs is determined by the overall design of the "Raft" type foundation and by constraints of the weight of each slab, which is a function of its thickness. On one hand, the thickness of the slab cannot be less than a minimum thickness that provides the required stiffness of the slab, and on the other hand, it cannot exceed a maximum thickness that will raise the weight of each slab beyond the capacity of locally available cranes.

Once the dimensions of the foundation, the number of layers, the number, shape and thickness of the slabs, and the number and location of bores for the long bolts or connecting members, have been decided upon (all depending upon construction calculations), the required slabs can be prefabricated. When it is desired to deploy the tower in a specific site, preparation works need to be done according to the conditions of the site, including soil conditions. Said site preparation works are normally limited to shallow excavation (normally up to 50 cm), compaction of the natural soil bed and backfill with granular material compacted in two or three layers. Thus, the preparation works take only a short while. For permanent deployment, casting a thin, well-leveled

layer of lean concrete on top of the compacted sub-base is preferable. The prefabricated slabs are then transported to the construction site, and rapidly assembled to form the finished foundation. The long bolts or connecting members 47, washers 54, nuts 45, locking washers 50 and locking nuts 52 are assembled together and inserted into the recesses, holes and bores of slabs 40 of the bottom most layer (Fig. 5), from underneath the slabs while they are securely held at an appropriate height above the ground, before it is laid down in its final position. The middle and upper layers are carefully placed transversely over the preceding layers, while being laced onto the upwardly projecting long bolts or connecting members 76 (Fig. 7) and 90 (Fig. 8). When the top most layer is laid, securing nuts are applied and tightened onto the threaded top end portions of long bolts or connecting members 76 and 90. Thereafter, the tower itself can be assembled, erected and secured onto said selected protruding long bolts or connecting members 90. When it is desired to remove the tower and its foundation, this process can be reversed. Alternatively, if the tower site is permanent, recesses in top slab 40 are preferably filled with any type of grout material.

It will be appreciated that the invention is not limited to what has been described hereinabove, merely by way of example. Rather, the invention is limited solely by the claims, which follow.

CLAIMS

1. A foundation for a tower, said foundation comprising a plurality of prefabricated slabs arranged to be assembled on site and joined together so as to function as a monolithic foundation.

2. The foundation according to claim 1, wherein the shape of the surface of said foundation is substantially a regular geometric shape.

3. The foundation according to claim 1, wherein the foundation includes a plurality of layers, each layer including a plurality of adjacent slabs joined transversely to at least one adjacent layer.

4. The foundation according to claim 3, wherein the thicknesses of all of said plurality of slabs in any one of said plurality of layers are substantially the same.

5. The foundation according to claim 4, wherein the surface area of each of said slabs is substantially equal to one half of the surface area of each of said layers.

6. The foundation according to claim 4, wherein each of said slabs includes a plurality of bores passing therethrough for accepting elongated connecting members, at least one end portion of each of said connecting members being threaded.

7. The foundation according to claim 6, wherein said elongated connecting members comprise long bolts.

8. The foundation according to claim 6, wherein said bores include lining sleeves.

9. The foundation according to claim 6, wherein each slab at the bottom layer of said foundationincludes recesses concentric with said bores.

10. The foundation according to claim 9, wherein said recesses have a cross-sectional area that is larger than the cross-sectional area of said bores.

11. The foundation according to claim 10, wherein said connecting members are threaded at both ends, and each of said recesses has a non-circular cross-section sufficiently large for receiving a securing nut mounted onto one of said threads.

12. The foundation according to claim 11, wherein said recesses are arranged for snug fit housing of said securing nuts.

13. The foundation according to claim 11, further including plate washers positioned on said connecting members within said recesses.

14. The foundation according to claim 11, further including a plurality of first non-rotating nut holding devices, which have a non-circular cross section equal to or larger than the cross section of said securing nuts, and are adapted to snug fit into said recesses and snug hold said securing nuts, for preventing rotation of said securing nuts.

15. The foundation according to claim 11, further including locking nuts positioned on said connecting members within said recesses, tightening of said locking nut against said securing nut on each of the elongated connecting members preventing rotation of said securing nuts.

16. The foundation according to claim 15, further comprising a pluralityof second non-rotating nut holding devices, wherein each said second nut holding devices comprises a substantially flat surface having surface area dimensions and contour suitable for snug fitting into one of said recesses, a circular hole suitable for inserting

said connecting member and co-axial thereto, and two parallel walls projecting from said flat surface substantially perpendicularly thereto, wherein each wall is positioned at an equal distance from the center of said circular hole and spaced apart at a distance substantially equal to the distance between two opposite edges of one of said locking nuts for snug fit housing and holding of said one of said locking nuts.

17. The foundation according to claim 11, wherein each of said bottom layer slabs further includes a metal plate imbedded therein, each of said metal plates including holes co-axial with said bores, for distributing loads created by tensioning of said elongated connecting members and for providing a support surface against which said securing nuts abut when tightened.

18. The foundation according to claim 10, wherein said elongated connecting members comprise long bolts, each of said recesses having a non-circular cross-section sufficiently large for receiving a head of one of said bolts.

19. The foundation according to claim 18, wherein said recesses are arranged for snug fit housing of said bolt heads.

20. The foundation according to claim 18, wherein each of said bottom layer slabs further includes a metal plate imbedded therein, each of said embedded plates including holes co-axial with said bores, for distributing loads created by tensioning of said connecting members and for providing a support surface against which said bolt heads abut when tightened.

21. The foundation according to claim 6, wherein at least some of said connecting members protrude from the top layer for joining together all said layers of said foundation and for connecting the tower to said elongated connecting members.

22. The foundation according to claim 20, wherein all of said elonagated connecting members protrude from the top layer for joining together all said layers of the foundation and for connecting the tower to said elongated connecting members.

23. The foundation according to claim 9, wherein each said slab of each said layer includes recesses concentric with said bores.

24. The foundation according to claim 9, wherein the top layer includes slabs substantially similar to said bottom layer slabs turned upside down.

25. A method of preparing a foundation for a tower, said method including:preparing prefabricated slabs including bores passing therethrough for receiving elongated connecting members;

preparing a site having a desired area;

placing a first layer of the prefabricated slabs on the site;

placing a second layer of the prefabricated slabs transversely on the first layer, while;

aligning the bores; and

joining together the first and second layers by means of elongated connecting members passing through the aligned bores.

26. The method according to claim 25, further including placing additional layers of prefabricated slabs on the second layer, aligning the bores of the additional layers with those of the first and second layers, and joining together all the layers by means of elongated connecting members passing through the aligned borestherein.

27. The method according to claim 26, the bottom layer of slabs having recesses substantially concentric with the bores therein.

28. The method according to claim 27, the slabs of at least any one layer other than the bottom layer including recesses substantially concentric with the bores therein.

29. The method according to claim 27, the slabs of the top layer being substantially similar to the bottom layer slabs turned upside down.

30. The method according to claim 25, the elongated connecting members being threaded at both ends, said method further including the step of assembling securing nuts, non-rotating nut holding devices, and locking nuts onto the bottom end portions of the connecting members before inserting the connecting members through the bores of the first layer.

31. The method according to claim 25, the connecting members being threaded at both ends, said method further including the step of assembling securing nuts onto bottom end portions of the connecting members before inserting the connecting members through the first layer.

32. The method according to claim 25, further including the step of inserting connecting members upwardly, through the first layer, before the step of placing the slabs of the first layer on the site.

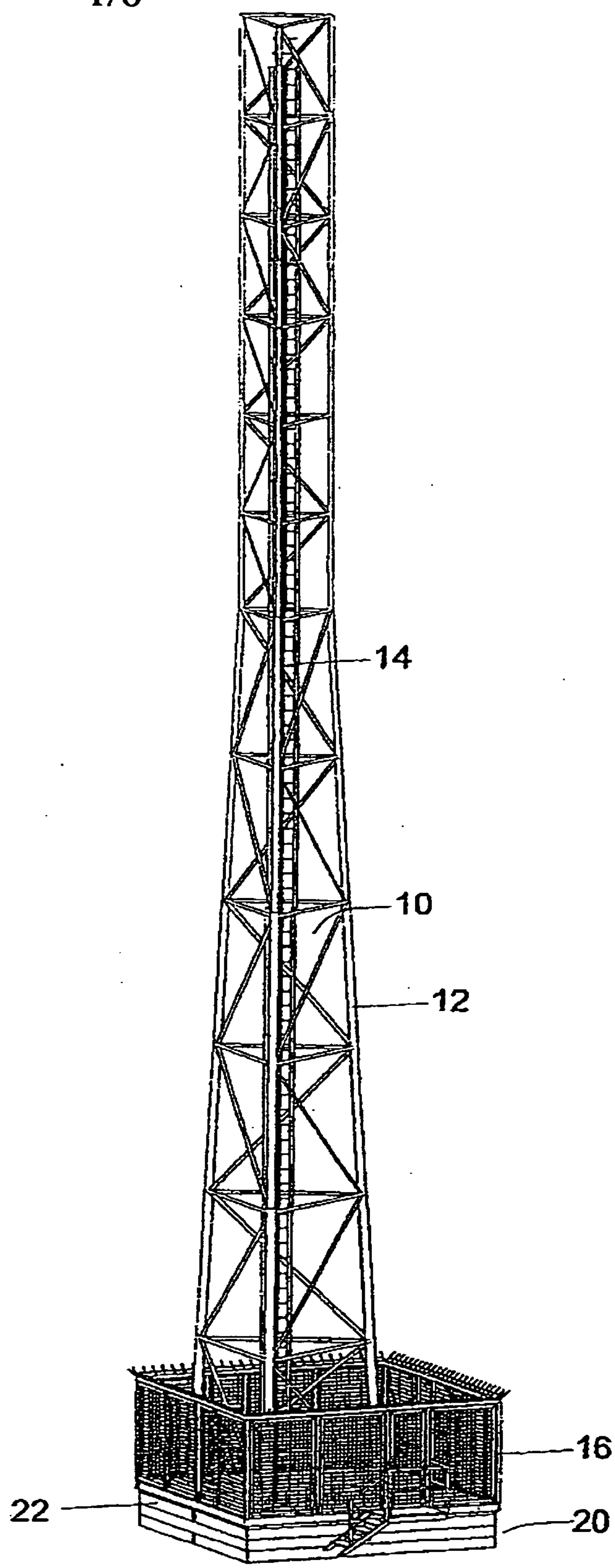


FIG.1

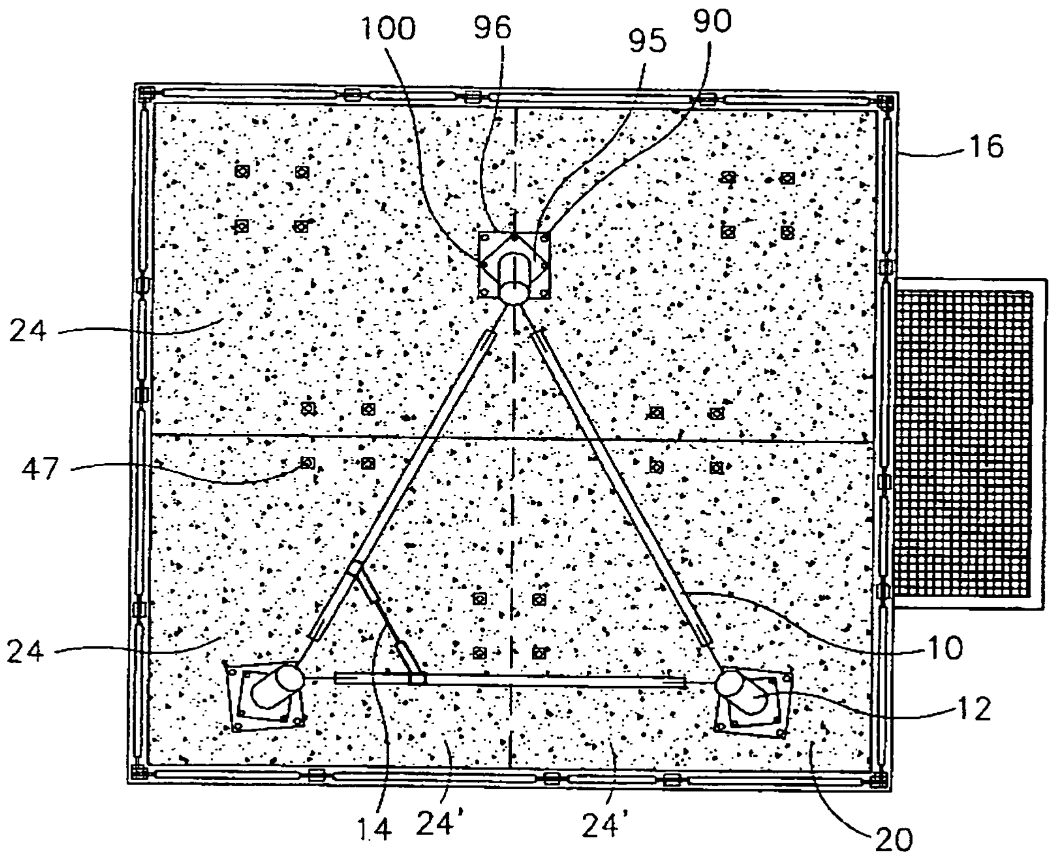


FIG.2

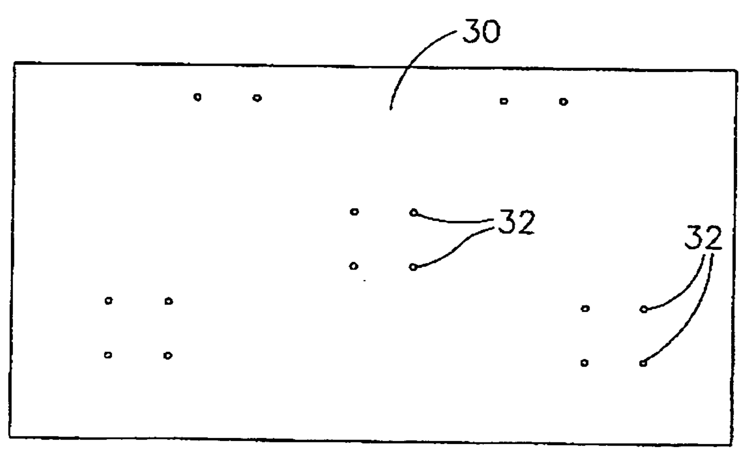


FIG.3

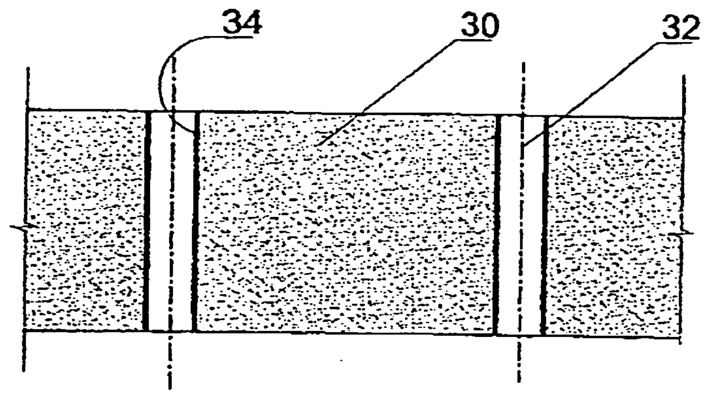


FIG. 4

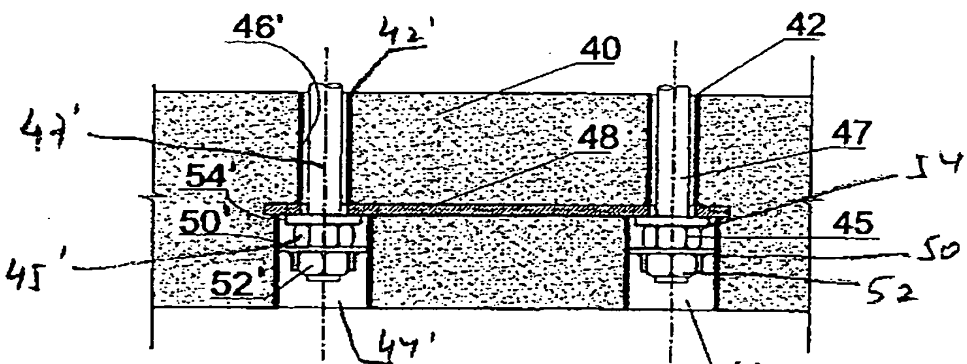


FIG. 5

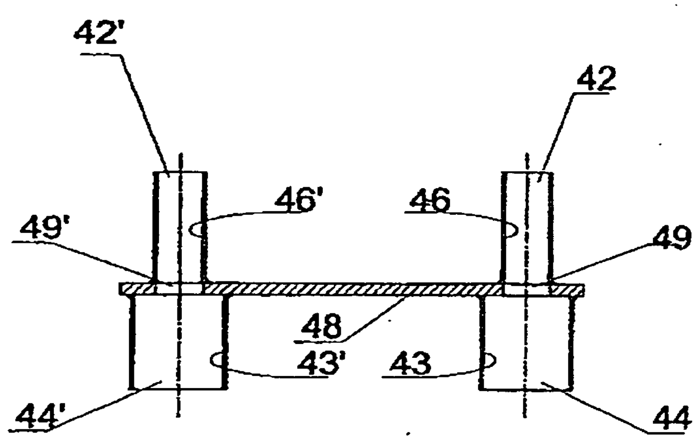


FIG. 6

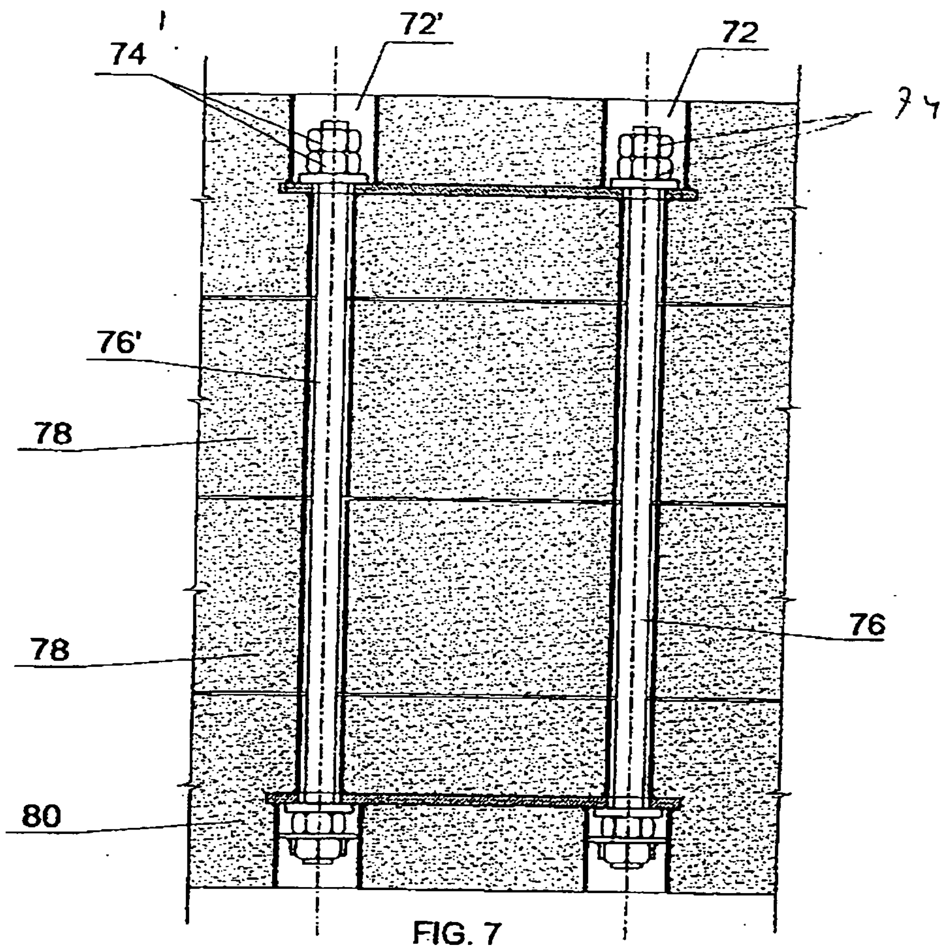


FIG. 7

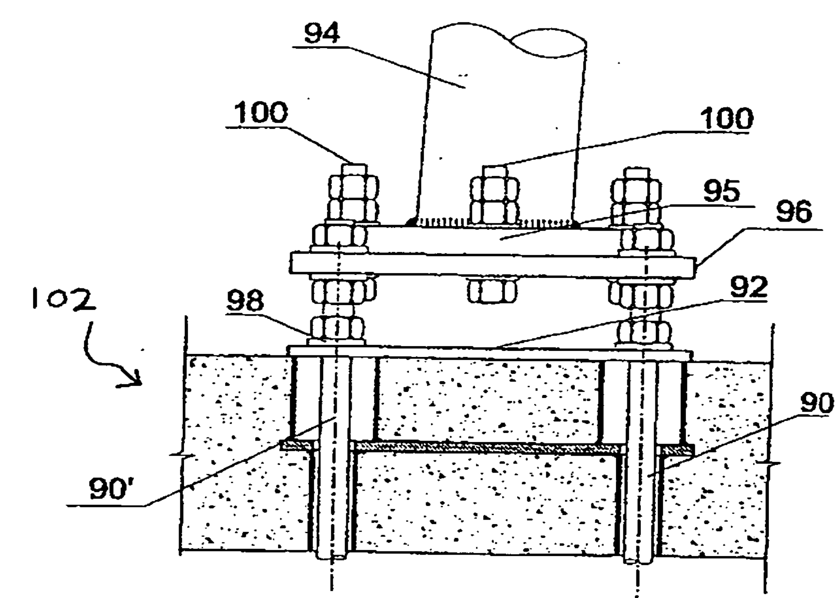


FIG. 8

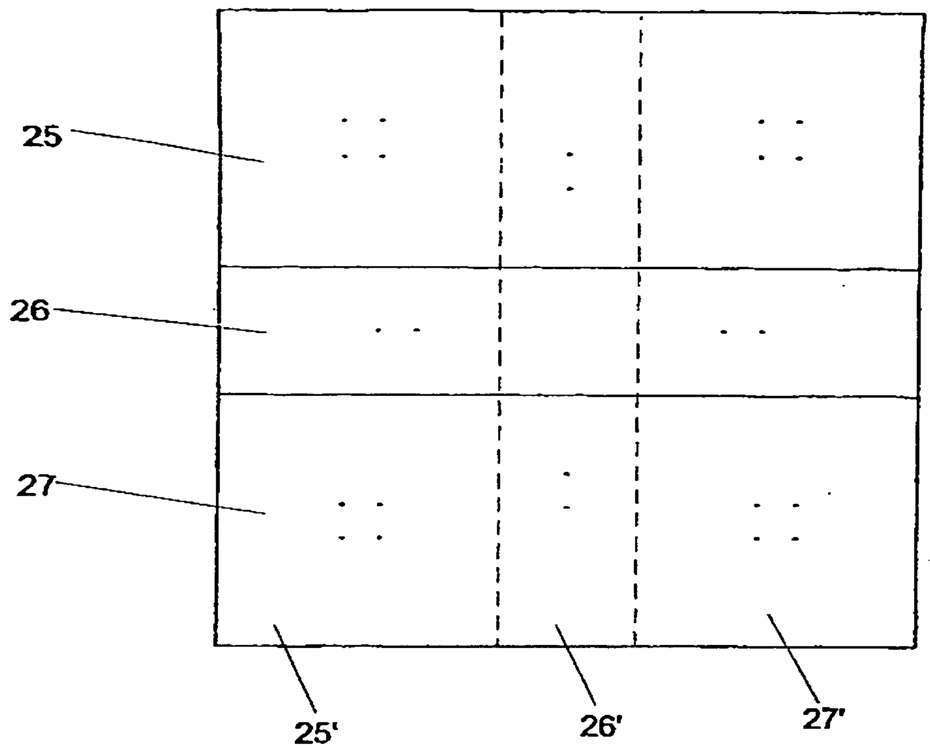


FIG. 9

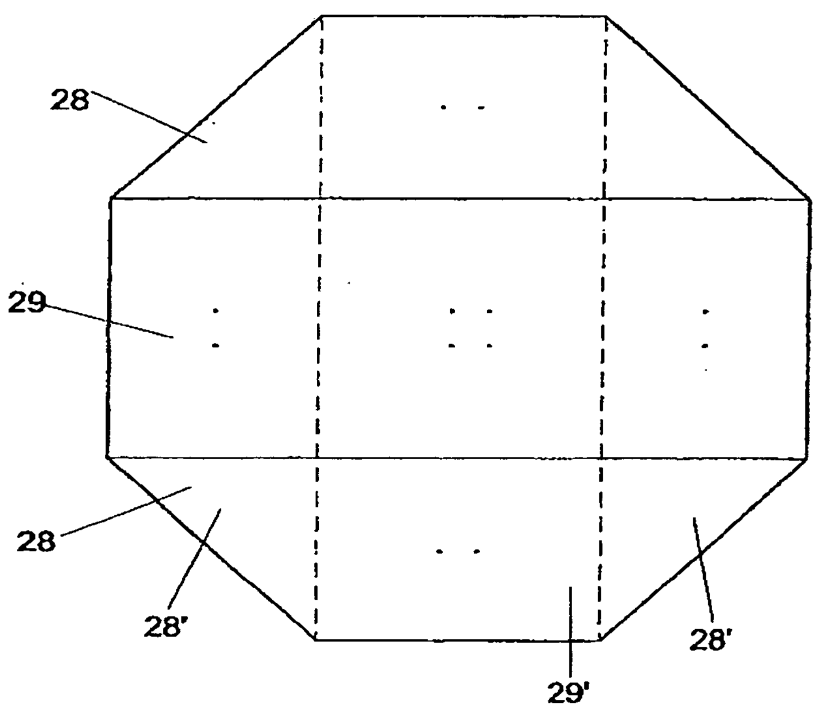
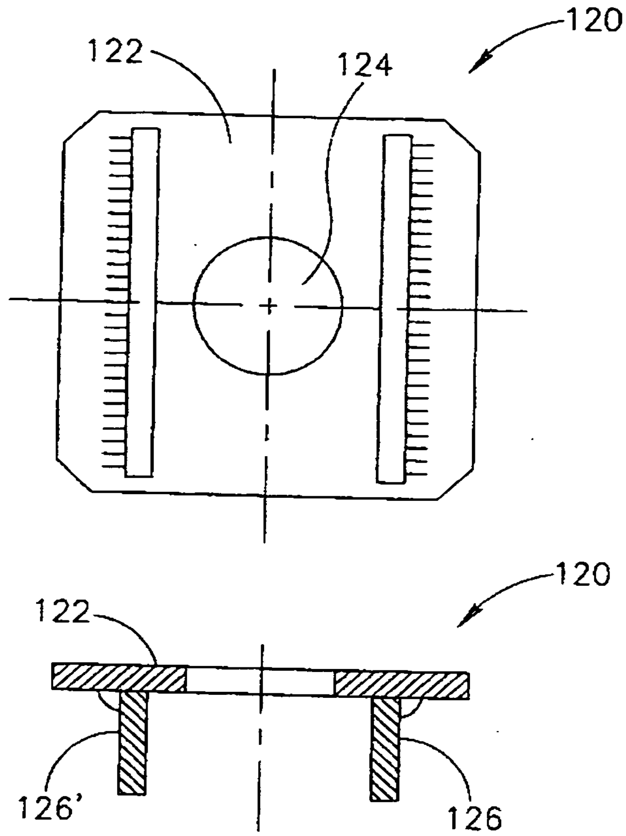


FIG. 10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126

FIG.11

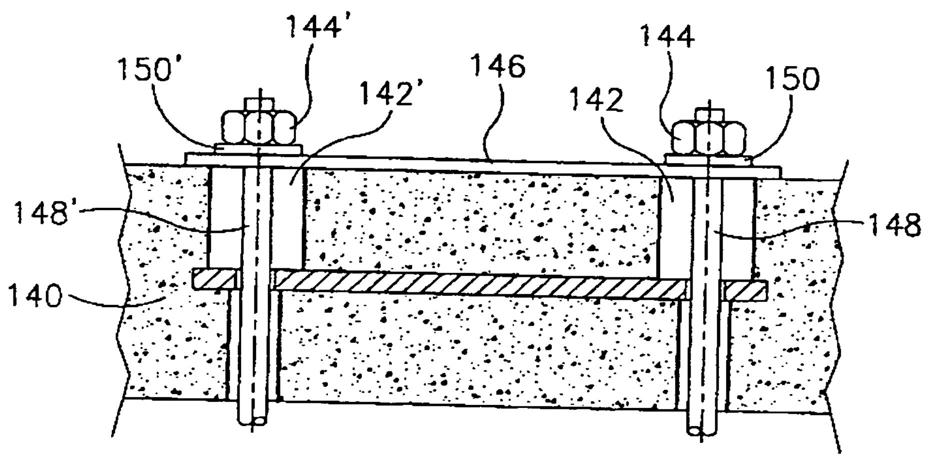
144'
150'
146
144
150
142'
142
148'
148
140

FIG.12

INTERN[redacted]ONAL SEARCH REPORT

[redacted]onal application No.
[redacted]T/IL01/00174

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : E02D 27/00; E02D 27/32
US CL : 52/292
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 52/292

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, 5,802,792 A (FIELDING) 08 SEPTEMBER 1998 (08/09/1998), see Figure 1 and 2	1-32
X	US 5,379,562 A (HOHMANN) 10 JANUARY 1995 (10/01/1995), see Figures 1 and 3	1-32
X	US 5,890,332 A (SKIDMORE) 6 APRIL 1999 (06/04/1999), see Figure 1 and 6	1-32
A,P	US 6,098,357 A (FRANKLIN 8 AUGUST 2000 (08/08/2000), see entire document	1-32
A,P	US 6,120,723 A (BUTLER) 19 SEPTEMBER 2000 (19/09/2000), entire document	1-32
A	US 5,134,828 A (BAUR) 4 AUGUST 1992 (04/08/1992), entire document	1-32

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search 28 June 2001 (28.06.2001)	Date of mailing of the international search report 23 MAY 2003
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Beth Stephan Telephone No. (703) 308-2168

Box III TEXT OF THE ABSTRACT (Continuation of Item 5 of the first sheet)

The technical features mentioned in the abstract do not include a reference sign between parentheses (PCT Rule 8.1(d)).

NEW ABSTRACT

A foundation(20) for a tower(10) is formed of a plurality of slabs(24-30,28',29') coupled together so as to function as a monolithic foundation(20).